Environmental Effects of Erosion on Water Quality

North Dakota Water Pollution Control Conference
Jeannie Schultz
Division of Water Quality
701.328.5244
jeschultz@nd.gov
April 4, 2011

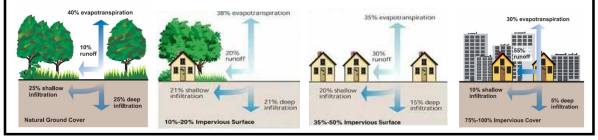
NORTH DAKOTA
DEPARTMENT *of* HEALTH

Erosion

- Process of wearing away rocks and soil deposits on the earth's surface by the action of water, ice, or wind
  - Focusing on water, specifically stormwater
  - Stormwater runoff is generated when precipitation from rain and snowmelt events flows over land or impervious surfaces and does not percolate into the ground
- Erosion is a natural process
- Under natural conditions soil erosion occurs at about the same rate as soil is formed

Urban Landscape's Influence on Erosion

- Urbanization contributes to erosion
- High concentrations of impervious surfaces such as roads and parking lots help water flow gain momentum
  - Flow faster
  - Greater intensity
- Water can also pick up any contaminants from urban settings and deposit them in water bodies of the state

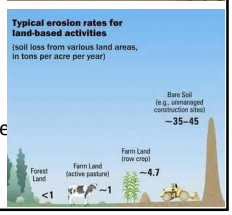


Stormwater Regulation

- During the 1970s and 1980s soil erosion became an issue due to its impact on water quality
- Stormwater runoff is our most common cause of water pollution
- Rainwater and snowmelt runoff run over streets, lawns, farms, and construction and industrial sites and pick up fertilizers, dirt, pesticides, oil and grease, and many other pollutants on the way to our rivers, and lakes
- Major efforts of water pollution control programs focused on point sources of pollution through regulation
  - Stormwater Program
  - To be considered a "point" source you must "discharge pollutants" into the "waters of the U.S."
  - Point sources include Industrial Facilities, MS4s, Construction Sites greater than 1 acre
  - Non-point sources include agriculture, construction less than 1 acre

Construction's Influence on Erosion

- Land left exposed or undergoing construction is vulnerable for increased rates of erosion
- Removing natural preventative measures like plants or grass cover leave it exposed
  - Plants are the natural version of vegetated buffers (BMP)
- As stormwater flows over a construction site, it can pick up pollutants like sediment, debris, and chemicals from paint, concrete washout, etc. and transport them to nearby sewer systems, or rivers



Effects of erosion impacts two places

- On-site Effects
  - Loss of topsoil
  - Water-holding capacity of the soil
  - Pollutants carried off by water
    - Any chemicals present on a site move with the eroded sediment or water
- Off-site Effects
  - Soil detached by accelerated wind or water may be transported considerable distances
  - The downstream effect is the movement of sediment and other various pollutants into waterways
    - Silting of dams
    - Disruption of lake ecosystems
    - Impaired water bodies
    - Contamination of drinking water
    - Increased downstream flooding

Impacts of Erosion

- Impaired soil quality
- Impaired water quality
- Impacts on wildlife
- Impacts on infrastructure
- Impacts on flood intensity
- Impacts on economics

Soil Quality

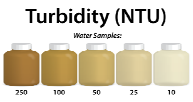
- Soil erosion is a form of soil degradation, or a reduction of soil quality
- Crops and other vegetation are reliant on the nutrient-rich topsoil, which is most vulnerable to erosion
- The long-term effect of this is a reduction in water retention capacities of the affected soil

Water Quality

- Pollutants may be transported to the water via erosion
  - Pesticides, metals, toxins, oil and grease
  - Phosphates can also enter waterways and when in high levels can result in algal blooms and lower the amount of dissolved oxygen
  - Sediment is the most common pollutant
    - Impact turbidity, potentially diminishing water quality and aquatic habitat

Turbidity

- Turbidity: how cloudy or murky the water is
- Problems caused by high turbidity:
  - Suspended sediment blocks sunlight, not allowing as much light to penetrate the water
    - Light is required for aquatic plants to perform photosynthesis
  - Fish have a harder time locating food, breathing through their gills, or finding mates based on visual cues
  - Deposition of sediment on the stream bottom can lead to :
    - Suffocation of fish eggs and benthic macro invertebrates
    - Destruction of natural spawning substrate
    - Smothering of spaces between rocks in the stream bottom necessary to fish eggs and aquatic insects
  - Impaired aesthetic qualities of a water body, making people less likely to fish or swim in the water



Impacts on Wildlife

- Destruction of aquatic habitat
  - Impaired breeding grounds
  - Fish that can't find mates
- Direct impacts on wildlife
  - Fish kills
  - Blocked gills

Infrastructure Concerns

- Siltation of waterways and reservoirs
- Clogging drainage ditches and stream channels
- Filling or damaging Damns
  - Increase chances of flooding, incurring potential cost and damage of further infrastructure

Economic Impacts

- Higher or additional costs in water treatment
- Loss of productivity in the soil
- Repair of damaged infrastructure
- Increased costs due to flooding
- Lost revenue from beneficial uses
  - Fishing, swimming, etc.

Case Study: Concrete Washwater

- Chemical processes that cause fresh concrete to stiffen and then harden are complex
- A by-product from this chemical reaction is calcium hydroxide, which is very alkaline and has a high pH (sometimes as high as 12.9)
- The pH scale is "logarithmic" meaning that each increase in number is a 10-fold increase in strength
- Water that comes into contact with cement, uncured concrete, or concrete dust can produce a strong alkaline solution that causes chemical burns to fish, insects and plants
- Even small volumes of concrete wastewater can cause immense damage to the environment

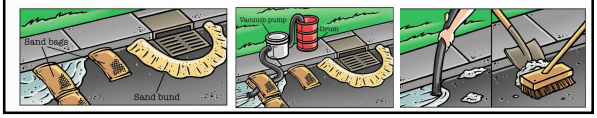
	pH	Quantity of water required to dilute 1 L of each pH level to neutral (pH = 7)
Neutral	7	0 L
Common pH Range of Concrete	10	1,000 L
	11	10,000 L
	12	100,000 L
	13	1,000,000 L

Why Can't We Just Dilute the Runoff?

- The logarithmic scale of pH means a huge volume of water is needed to dilute the wastewater to safe levels
- To dilute 1 liter of 'neat' runoff to a safer pH of 7, approximately 10,000 (or more) liters of water would be needed
- If the correct dilution rates were not achieved in the attempt to dilute the contaminant, you would simply increase the size of the problem on a massive scale rather than fixing it

Pollution Control

- In order to control concrete washwater, preventing exposure to stormwater systems or waterways is necessary
  - Water pools or ponds
- Plan and implement your wastewater control measures before starting jobs
- Plan for spills before they happen
- Always contain washwater and slurry
- Don't dispose of wastewater through the stormwater system (even if you dilute it)
- Clean up after yourself regularly, but especially once a job is done



Control Measures

- Erosion Controls
- Sediment Controls

Erosion Solutions

- Prevention
  - Preventing erosion by using properly installed BMPs
  - Consider using more than one BMP to prevent erosion
- Maintenance
  - Maintaining site conditions, limiting exposure of pollutants or trash, repairing BMPs if degraded
- Observance
  - Regular inspections and observance on work sites to ensure BMPs are working efficiently
  - Updating the SWPPP and altering the approach to limit erosion if conditions change or preventative measures are not working

Questions?